

U.S. Patent Application Serial No. 09/745,998
Response dated February 11, 2004
Reply to OA of **December 22, 2003**

IN THE CLAIMS:

Please amend claims 13 and 32 as follows:

Claim 1 (Original): A light emitting device comprising:

a first n-type layer;

a first p-type layer;

a light emitting layer arranged so as to be interposed between said first n-type layer and said first p-type layer and having a strain generating a piezoelectric effect; and

a second n-type layer provided between at least said light emitting layer and said first p-type layer and having a wider bandgap than that of said light emitting layer,

a potential in said light emitting layer whose gradient is generated by said piezoelectric effect being higher on the side of said first n-type layer than that on the side of said first p-type layer.

Claim 2 (Original): The light emitting device according to claim 1, wherein

said first p-type layer comprising a first cladding layer, and

the bandgap of said second n-type layer is narrower than that of said first cladding layer.

Claim 3 (Original): The light emitting device according to claim 1, wherein

a material composing said light emitting layer has a wurtzite structure.

Claim 4 (Original): The light emitting device according to claim 3, wherein

a principal plane of said light emitting layer is approximately perpendicular to a <0001> direction.

Claim 5 (Original): The light emitting device according to claim 1, wherein a material comprising said light emitting layer has a zinc-blende structure.

Claim 6 (Original): The light emitting device according to claim 5, wherein a principal plane of said light emitting layer is approximately perpendicular to a <111> direction.

Claim 7 (Original): The light emitting device according to claim 1, wherein said strain generating a piezoelectric effect includes a strain for compressing said light emitting layer in an in-plane direction of said light emitting layer.

Claim 8 (Original): The light emitting device according to claim 1, wherein said strain generating a piezoelectric effect includes a strain for extending said light emitting layer in an in-plane direction of said light emitting layer.

Claim 9 (Original): The light emitting device according to claim 1, wherein

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a material composing said light emitting layer is a III-V group compound semiconductor.

Claim 10 (Original): The light emitting device according to claim 9, wherein
said III-V group compound semiconductor is a nitride based semiconductor including at least
one of boron, gallium, aluminum, and indium.

Claim 11 (Original): The light emitting device according to claim 1, wherein
a material composing said light emitting layer is a II-VI group compound semiconductor or
a I-VII group compound semiconductor.

Claim 12 (Original): The light emitting device according to claim 1, wherein
said light emitting layer has a quantum well structure comprising one or more well layers
having a strain generating a piezoelectric effect and two or more barrier layers arranged so as to
interpose said well layer therebetween, and
the potential in said well layer whose gradient is generated by said piezoelectric effect is
higher on the side of said first n-type layer than that on the side of said first p-type layer.

Claim 13 (Currently Amended): The light emitting device according to claim 12, wherein

acceptor levels and/or donor levels are non-uniformly formed in the direction of confinement in the light emitting layer having said quantum well structure so that in order to decrease a potential gradient generated by the piezoelectric effect in the direction of confinement is decreased in said quantum well structure.

Claim 14 (Original): The light emitting device according to claim 13, wherein
in said well layer, more acceptor levels are formed in its portion on the side of said first n-type layer having a higher potential generated as a result of the piezoelectric effect than those in its portion on the side of said first p-type layer having a lower potential.

Claim 15 (Original): The light emitting device according to claim 1, wherein
in said well layer, more donor levels are formed in its portion on the side of said first p-type layer having a lower potential generated as a result of the piezoelectric effect than those in its portion on the side of said first n-type layer having a higher potential.

Claim 16 (Original): The light emitting device according to claim 13, wherein
in said barrier layer, more acceptor levels are formed in its portion in contact with an interface of said well layer on the side of said first n-type layer having a higher potential generated as a result of the piezoelectric effect than those in its portion in contact with an interface of said well layer on the side first p-type layer having a lower potential.

Claim 17 (Original): The light emitting device according to claim 13, wherein
in said barrier layer, more donor levels are formed in its portion in contact with an interface
of said well layer on the side of said first p-type layer having a lower potential generated as a result
of the piezoelectric effect than those in its portion in contact with an interface of said well layer on
the side of said first n-type layer having a higher potential.

Claim 18 (Original): The light emitting device according to claim 1, wherein
both the acceptor levels and the donor levels are formed in the light emitting layer having
said quantum well structure.

Claim 19 (Original): The light emitting device according to claim 18, wherein
the concentration of said acceptor levels and the concentration of said donor levels are
approximately equal to each other.

Claim 20 (Original): A light emitting device comprising:
a first n-type layer;
a first p-type layer;
a light emitting layer arranged so as to be interposed between said first n-type layer and said
first p-type layer and having a strain generating a piezoelectric effect; and a second p-type layer
provided between at least said light emitting layer and said first n-type layer and having a wider

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bandgap than that of said light emitting layer,

a potential in said light emitting layer whose gradient is generated by said piezoelectric effect being higher on the side of said first n-type layer than that on the side of said first p-type layer.

Claim 21 (Original): The light emitting device according to claim 20, wherein
said first n-type layer comprises a second cladding layer, and
the bandgap of said second p-type layer is narrower than that of said second cladding layer.

Claim 22 (Original): The light emitting device according to claim 20, wherein
a material composing said light emitting layer has a wurtzite structure.

Claim 23 (Original): The light emitting device according to claim 22, wherein
a principal plane of said light emitting layer is approximately perpendicular to a <0001>
direction.

Claim 24 (Original): The light emitting device according to claim 20, wherein
a material composing said light emitting layer has a zinc-blende structure.

Claim 25 (Original): The light emitting device according to claim 24, wherein
a principal plane of said light emitting layer is approximately perpendicular to a <111>
direction.

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Claim 26 (Original): The light emitting device according to claim 20, wherein
said strain generating a piezoelectric effect includes a strain for compressing said light
emitting layer in an in-plane direction of said light emitting layer.

Claim 27 (Original): The light emitting device according to claim 20, wherein
said strain generating a piezoelectric effect includes a strain for extending said light emitting
layer in an in-plane direction of said light emitting layer.

Claim 28 (Original): The light emitting device according to claim 20, wherein
a material composing said light emitting layer is a III-V group compound semiconductor.

Claim 29 (Original): The light emitting device according to claim 28, wherein
said III-V group compound semiconductor is a nitride based semiconductor is a nitride based
semiconductor including at least one of boron, gallium, aluminum, and indium.

Claim 30 (Original): The light emitting device according to claim 20, wherein
a material composing said light emitting layer is a II-VI group compound semiconductor or
a I-VII group compound semiconductor.

Claim 31 (Original): The light emitting device according to claim 20, wherein
said light emitting layer has a quantum well structure comprising one or more well layers

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having a strain generating a piezoelectric effect and two or more barrier layers arranged so as to interpose said well layer therebetween, and

a potential in said well layer whose gradient is generated by said piezoelectric effect is higher on the side of said first n-type layer than that on the side of said first p-type layer.

Claim 32 (Currently Amended): The light emitting device according to claim 31, wherein acceptor levels and/or donor levels are nonuniformly formed in the direction of confinement in the light emitting layer having said quantum well structure so that in order to decrease a potential gradient generated by the piezoelectric effect in the direction of confinement is decreased in said quantum well structure.

Claim 33 (Original): The light emitting device according to claim 32, wherein in said well layer, more acceptor levels are formed in its portion on the side of said first n-type layer having a higher potential generated as a result of the piezoelectric effect than those in its portion on the side of said first -type having a lower potential.

Claim 34 (Original): The light emitting device according to claim 32, wherein in said well layer, more donor levels are formed in its portion on the side of said first p-type layer having a lower potential generated as a result of the piezoelectric effect than those in its portion on the side of said first n-type layer having a higher potential.

Claim 35 (Previously Presented): The light emitting device according to claim 32, wherein in said barrier layer, more acceptor levels are formed in its portion in contact with an interface of said well layer on the side of said first n-type layer having a higher potential generated as a result of the piezoelectric effect than those in its portion in contact with an interface of said well layer on the side of said first p-type layer having a lower potential.

Claim 36 (Original): The light emitting device according to claim 32, wherein in said barrier layer, more donor levels are formed in its portion in contact with an interface of said well layer on the side of said first p-type layer having a lower potential generated as a result of the piezoelectric effect than those in its portion in contact with an interface of said well layer on the side of said first n-type layer having a higher potential.

Claim 37 (Original): The light emitting device according to claim 32, wherein both the acceptor levels and the donor levels are formed in the light emitting layer having said quantum well structure.

Claim 38 (Original): The light emitting device according to claim 37, wherein the concentration of said acceptor levels and the concentration of said donor levels are approximately equal to each other.